

# **APPENDIX II**

## **TAB C**

# Rebuttal Analysis of Kenneth Miller's Statement

by

**Michael J. Behe**

Professor of Biological Sciences

Lehigh University

Bethlehem, Pennsylvania

May 15, 2005

1 "The Scientific Status of Evolutionary Theory"  
 1.1 Blurring the meanings of the word "evolution"

It is important to be aware in this section (and throughout his report) that Miller slides back and forth between the various definitions of the word "evolution". He acknowledges three distinct, core propositions of Darwinian evolution: 1) "life has changed over time" 2) "living things share common ancestors"; 3) "biological change ... is driven by forces observable in the world today", in particular, "a process known as natural selection." Yet these three propositions are logically separable. There is no reason why all three have to be correct. Further, the amount of evidence supporting one proposition may be greater, the amount supporting another proposition much less or nonexistent.

In fact the three "core propositions" do indeed vary enormously in the amount of evidence that support them. Absolutely no one disputes "change over time". Common descent is more controversial but does not contradict intelligent design theory, since an intelligent agent may have intended to use common descent to produce life. The only definition of "evolution" that intelligent design directly disputes is the unintelligent mechanism of natural selection (and even then can agree that selection explains at least some features of life). It is not legitimate for Darwinists to try to "borrow" legitimacy for their poorly supported claim of natural selection from the well-supported claim of change over time.

Intelligent design proponents are not alone in disputing the power of natural selection. For example, as I pointed out in my own expert report, scientists called complexity theorists also doubt that natural selection is a complete answer to life. In his book *Origins of Order: Self-Organization and Selection in Evolution* (Oxford University Press, 1993) the well-known complexity theorist Stuart Kauffman of the University of Calgary wrote:

Darwin and evolutionism stand astride us, whatever the mutterings of creation scientists. But is the view right? Better, is it adequate? I believe it is not. It is not that Darwin is wrong, but that he got hold of only part of the truth. For Darwin's answer to the sources of the order we see all around us is overwhelmingly an appeal to a single singular force: natural selection. It is this single-force view which I believe to be inadequate, for it fails to notice, fails to stress, fails to incorporate the possibility that simple and complex systems exhibit order spontaneously.<sup>1</sup>

Thus it is not only ID proponents who doubt the sufficiency of natural selection, but also other scientists too.

1.2 Miller's extravagant claims for evolution

In this section Miller makes extravagant claims for evolutionary theory. It might be useful to point them out to show that Darwinists tend to greatly exaggerate the status of their theory. Miller writes:

in nearly a century and a half of investigation, not a single piece of scientific evidence has emerged to contradict the idea that a process of evolutionary change gave rise to the species that exist

today.<sup>2</sup>

Again, ID does not question "evolution"; ID focuses exclusively on the unintelligent mechanism of natural selection. Miller should be asked if any evidence at all contradicts Darwin's proposed mechanism of natural selection. It should also be pointed out that, as I wrote in my expert report, the embryo drawings of Ernst Haeckel, which appeared in a large number of Biology textbooks over the past century, including earlier editions of Miller's own texts, were shown to be fraudulent. Indeed Miller himself acknowledges that in his textbook "the fraudulent drawings of Ernst Haeckel are pointed out."<sup>3</sup> Now, the question is, if the discovery that a century-old showcased piece of evidence for Darwinian evolution is a fraud does not count as a strike against evolution, what in the world would?

Miller writes in this section that in addition to natural selection, other mechanisms of evolution include "genetic recombination, transposition, horizontal gene transfer, gene duplication, sexual selection, and developmental mutations."<sup>4</sup> In fact *none* of these are different mechanisms of evolution. Except for sexual selection, all the other phenomena listed by Miller are simply ways in which random variation is produced in nature. The results of all of these processes are then sifted by natural selection. Darwin's mechanism is that of natural selection — it is the exact same mechanism here as Darwin proposed. Sexual selection is simply a special case of natural selection, in which mate choice determines reproductive success. However, mate choice itself is presumed to be driven by natural selection.<sup>5</sup> Thus there is only one Darwinian mechanism — natural selection.

After writing that "There is considerable discussion and debate within the scientific community as to the relative importance of these and other mechanisms...", in his final paragraph Miller asserts:

Significantly, none of these debates undermines the scientific standing of evolution (note he slips from discussing the mechanism to speaking of "evolution" in general)... In fact, each of these has added to our understanding of the ways in which evolution works, and strengthened the core elements of the theory.<sup>6</sup>

Miller states this despite the fact, as I pointed out in my expert report, that the reason that sexual reproduction is widespread has remained a mystery to Darwinian theory for over a hundred years, despite the fact that the eminent evolutionary biologist George C. Williams wrote "there is a kind of crisis at hand in evolutionary biology" because of its inability to explain sex.<sup>7</sup> Miller should be asked if a century-old "crisis" in understanding sexual reproduction doesn't "undermine the scientific standing of Darwinian theory", just what would?

### 1.3 Medicinal research looks for the *limits* to evolution

One set of examples that Miller uses in this section should be challenged. In order to show the practical importance of evolution he writes:

Evolutionary theory is used to design new drugs based on the process of natural selection, to check the spread of insects able to prey upon genetically-modified plants.... Evolutionary theory provides the basic rationale for the three drug HIV regimen ... and is at the heart of efforts to control the spread of infectious diseases. This makes evolution a key weapon in medicine's battles against infectious killers such as tuberculosis and malaria.<sup>8</sup>

So he touts evolution in general and natural selection in particular as important to medicine. But here is the critical point, a point which turns Miller's claim on its head: in considering how to stop infectious diseases, scientists are looking for LIMITS to evolution. In other words, scientists realize that viruses and bacteria can change to a certain degree, and so are looking for weapons that are beyond their ability to evolve resistance. The reason that physicians use three drugs simultaneously in their treatment of HIV patients is because, while the virus can mutate rapidly to evolve resistance to one drug, its ability to mutate to simultaneously develop resistance to three drugs is so unlikely that it is beyond the ability of the virus to develop resistance.

One example of this that I cited in my own expert report is from the laboratory of Barry Hall at the University of Rochester.

This is exemplified in some recent papers from the laboratory of Professor Barry G. Hall at the University of Rochester. Although he is not an advocate of intelligent design, Professor Hall nonetheless does not automatically assume Darwinian processes can do everything. For example, he writes in a paper in the journal *Antimicrobial Agents and Chemotherapy*: "Instead of assuming that metallo- $\beta$ -lactamases will evolve rapidly, it would be highly desirable to accurately predict their evolution in response to carbapenem selection." Using a method he developed, he predicts that bacteria will be unable to develop resistance to an antibiotic called imipenem. He writes in the abstract of his paper: "The results predict, with >99.9% confidence, that even under intense selection the IMP-1  $\beta$ -lactamase will not evolve to confer increased resistance to imipenem."<sup>9</sup>

So Barry Hall is looking to find the limits to evolution in order to help develop better antibiotics.

I think this point deserves great emphasis: It is critical to the development of better antibiotics, pesticides and drugs to determine the limits of Darwinian evolution. The situation is exactly opposite to what Miller states: "This makes [LIMITS TO] evolution a key weapon in medicine's battles against infectious killers such as tuberculosis and malaria." Yet if students are taught uncritically that evolution has no limits, that it can explain virtually anything, that it can develop all of the complex machinery of life, then when some of them grow up to be medical researchers they may be ill-equipped to discover the next generation of medicines. Thus it is important to teach students that evolution may have limits.

2 "Biology by Miller and Levine"

2.1 Mechanism again

Miller ends the first paragraph by of this section by quoting the National Academy of Sciences, "The scientific consensus around evolution is overwhelming."<sup>10</sup> Again, however,

intelligent design does not dispute "evolution"; it disputes the claim that an unintelligent mechanism such as natural selection can explain all the complexity of life. Again, complexity theorists such as Stuart Kauffman (quoted earlier) also disagree that natural selection accounts for aspects of cellular complexity. Thus the consensus around the *mechanism* of evolution is not overwhelming.

## 2.2 Two useful points of agreement

In this section Miller discusses his textbook, and quotes the following section:

A useful theory may become the dominant view among the majority of scientists, but no theory is considered absolute truth. Scientists analyze, review, and critique the strengths and weaknesses of theories. As new evidence is uncovered, a theory may be revised or replaced by a more useful explanation. Sometimes, scientists resist a way of looking at nature, but over time new evidence determines which ideas survive and which are replaced.<sup>11</sup>

*This is a very good statement*, and it may be good to emphasize to the court that this is exactly what the school board wishes to do. Thus Miller agrees that this is an important point for the students to apprehend. However, the board judges that this point should be emphasized more strongly than does the Miller and Levine textbook.

He writes:

our prominent mention of continuing debate on crucial issues such as speciation and the origin of life clearly indicates that evolutionary theory remains incomplete and unfinished, highlighting some of the uncertainties of this theory, which exist side-by-side with its remarkable strengths.<sup>12</sup>

This is a telling admission. If evolutionary theory is "incomplete and unfinished", if it has not explained speciation and the origin of life, if it has uncertainties, then those areas remain open, and possible answers to those questions cannot be artificially restricted to the ones that Kenneth Miller or other Darwinists would prefer. Students should be encouraged to think of many possibilities, even ones outside of Darwinian theory.

## 3 "Language of the Dover statement"

### 3.1 Evolution as theory and fact

#### 3.1.1 Miller concedes evolution is not a fact

Miller concedes that "The Board statement correctly describes a theory ... and it quite properly advises students that they should keep an open mind 'with respect to any theory'".<sup>13</sup> Again, *this is a critical admission*, which shows that the Board's actions are quite reasonable. Miller goes on here to claim that the Board "disregards its own advice on these matters by calling attention to just one theory, the theory of evolution." (It's hard to understand what Miller means by the Board "disregarding its own advice" — the Board never gave "advice" that some theory in particular shouldn't have particular attention on



these points. Miller is trying to put his own spin on the Board's statement.) There are, however, excellent, defensible, quite rational reasons for emphasizing these correct, proper points with regard to the theory of evolution in particular, as discussed below.

Miller writes in regard to the Board's statement that the theory of evolution "is not a fact":

The Board's emphasis that evolution is not a fact might be appropriate if they had pointed out that no scientific theory is a fact, and that all scientific theories continued to be tested in light of new scientific discoveries. Instead, their claim that evolution "is not a fact" is clearly designed to undermine the scientific standing of evolution...<sup>14</sup>

However, for at least two reasons the board might quite properly and rationally emphasize to students that evolution is a theory, not a fact: 1) some people in the field have claimed that evolution is indeed a fact; 2) Darwinian evolution is claimed by some to have far reaching implications, well beyond science, including not only philosophical and theological ones, but even legal and literary implications! Since Darwinian evolution is claimed to be so far reaching it is justifiable that its claims should be treated with special scrutiny. I treat each of these reasons in the following two subsections.

### 3.1.1.1 Some claim that evolution is indeed a "fact, fact, FACT!"

Students might easily be confused about the status of evolution if they come across the public claims by prominent Darwinists that it is a fact. For example, the Darwinian philosopher of biology Michael Ruse has written:

As noted in the Preface, one often sees it said that 'evolution is not a fact, but a theory.' Is this the essence of my claim? Not really! Indeed, I suggest that this wise-sounding statement is confused to the point of falsity: it almost certainly is if, without regard for cause, one means no more by 'evolution' than the claim that all organisms developed naturally from primitive beginnings. Evolution is a fact, *fact, FACT!*<sup>15</sup>

The distinguished philosopher Alvin Plantinga catalogs some instances of claimed facthood for evolution:

Evolution, says Francisco J. Ayala, is as certain as "the roundness of the earth, the motions of the planets, and the molecular constitution of matter." "The Theory of Evolution: Recent Successes and Challenges," in *Evolution and Creation*, ed. Eran McMullin (Notre Dame: University of Notre Dame Press, 1985), p. 60. According to Stephen J. Gould, evolution is an established fact, not a mere theory; and no sensible person who was acquainted with the evidence could demur. "Evolution as Fact and Theory" in *Hen's Teeth and Horse's Toes* (New York: W.W. Norton and Company, 1980), pp. 254-55. According to Richard Dawkins, the theory of evolution is as certainly true as that the earth goes around the sun. This astronomical comparison apparently suggests itself to many; in "Evolutionary Biology and the Study of Human Nature" (presented at a consultation on Cosmology and Theology sponsored by the Presbyterian (USA) Church in Dec., 1987) Philip Spieth claims that "A century and a quarter after the publication of *The Origin of Species*, biologists can say with confidence that universal genealogical relatedness is a conclusion of science that is as firmly established as the revolution of the earth about the sun." And Michael Ruse adds his nuanced and modulated view that "evolution is fact, *fact, FACT!*"<sup>16</sup>

The point is that some proponents of Darwinism state strongly and publicly that evolution is a fact. Thus the Board has a quite justifiable reason to educate students about the true status of evolutionary theory in particular, even if it does not feel it has to spend the same effort for other theories.

3.1.1.2 The theory of evolution is claimed to have very far reaching implications

Darwin's theory of evolution is utterly different from, say, the theory of gravity or electromagnetic theory, because of the philosophical, theological, and other non-scientific claims that have been made on its behalf. No one today claims that, say, electromagnetic theory allows a person to be "an intellectually fulfilled atheist", but that claim has been made for Darwin's theory. No one ever said that the theory of gravity acts as a "universal acid", or that it is a "nihilistic idea" that "deprives nature of purpose, on the global and the local scale." But that has been claimed for Darwin's theory. Since the theory is claimed to be so far-reaching, it is eminently justifiable to pay special attention to its evidentiary base.

Here are some of the claims that have been made for Darwin's theory:

- In the high school textbook *Biology* by expert witness for the plaintiffs Kenneth Miller and Joseph Levine, in a section entitled "The Significance of Evolutionary Theory", they write:

[t]he influence of evolutionary thought extends far beyond biology. Philosopher J. Collins has written that "there are no living sciences, human attitudes, or institutional powers that remain unaffected by the ideas ... released by Darwin's work."<sup>17</sup>

- In *Finding Darwin's God: A Scientist's Search for Common Ground Between God and Evolution* Brown University biologist and expert witness for the plaintiffs Kenneth R. Miller writes that:

[God] made the world today contingent upon the events of the past. He made our choices matter, our actions genuine, our lives important. In the final analysis, He used evolution as the tool to set us free.<sup>18</sup>

- In *God After Darwin: A Theology of Evolution* the Georgetown University theologian and expert witness for the plaintiffs John Haught writes of the implications of Darwin's theory for Christian theology.
- The evolutionary biologist Richard Dawkins of Oxford University wrote, "Darwin made it possible to be an intellectually-fulfilled atheist."<sup>19</sup>
- The Darwinian philosopher Daniel Dennett of Tufts University wrote in his best selling book *Darwin's Dangerous Idea*<sup>20</sup> that Darwinism is a "universal acid" that eats through our most cherished beliefs:



Darwin's idea had been born as an answer to questions in biology, but it threatened to leak out, offering answers— welcome or not—to questions in cosmology (going in one direction) and psychology (going in the other direction). If [the cause of design in biology] could be a mindless, algorithmic process of evolution, why couldn't that whole process itself be the product of evolution, and so forth all the way down? And if mindless evolution could account for the breathtakingly clever artifacts of the biosphere, how could the products of our own "real" minds be exempt from an evolutionary explanation? Darwin's idea thus also threatened to spread all the way up, dissolving the illusion of our own authorship, our own divine spark of creativity and understanding.<sup>21</sup>

- Duke University philosopher Alex Rosenberg wrote in *Biology and Philosophy* that:

No one has expressed the destructive power of Darwinian theory more effectively than Daniel Dennett. Others have recognized that the theory of evolution offers us a universal acid, but Dennett, bless his heart, coined the term. ... In short it has made Darwinians into metaphysical nihilists denying that there is any meaning or purpose to the universe, its contents and its cosmic history. But in making Darwinians into metaphysical nihilists, the solvent algorithm should have made them into ethical nihilists too. For intrinsic values and obligations make sense only against the background of purposes, goals, and ends which are not merely instrumental. But the leading Darwinian philosophers have shied away from this implication and instead have embraced ethical naturalism. And this despite the ever-increasing power of Darwinism to explain away normative ethics as a local adaptation.<sup>22</sup>

- Larry Amhart, a Professor of Political Science at Northern Illinois University, writes in his book *Darwinian Natural Right: The Biological Ethics of Human Nature* that Darwinism can illuminate our political choices. He writes in *Darwinian Conservatism* that "Darwinian biology sustains conservative social thought by showing how the human capacity for spontaneous order arises from social instincts and a moral sense shaped by natural selection in human evolutionary history."<sup>23</sup>

- The Princeton University philosopher Peter Singer writes in *A Darwinian Left: Politics, Evolution, and Cooperation* "suggests we incorporate a Darwinian ethic of cooperation into our political thought and reflect carefully on the consequences of our remedies for the evils of the world."<sup>24</sup>

- In *Literary Darwinism* the University of Missouri English Professor Joseph Carroll's essays

provide Darwinist readings of major literary texts such as *Pride and Prejudice* and *Tess of the d'Urbervilles*, and analyze literary Darwinism in relation to the affiliated fields of evolutionary metaphysics, cognitive rhetoric, and ecocriticism. Collecting the essays in a single volume will provide a central point of reference for scholars interested in consulting what the "foremost practitioner" (*New York Times*) of Darwinian literary criticism has to say about his field.<sup>25</sup>

This very incomplete list gives a flavor of the sweeping claims that have been made on behalf of Darwin's theory in fields very far removed from biology. Because of the expansive implications that are claimed for the theory, it is completely justifiable to subject it to stricter scrutiny than other scientific theories for which such sweeping claims are not made. Miller

implies that the Board wants "to argue that evolution alone should be regarded as tentative." No one ever said that. However, because of the reasons stated above, it is rational to specifically point out to students that evolution, too, is tentative.

#### 4 "Intelligent Design" as a Scientific Alternative to Evolution"

##### 4.1 Several mischaracterizations of Intelligent Design Theory

Miller starts this section by asserting that:

"Intelligent Design Theory" is a new anti-evolution movement that has been presented as an alternative to an older formulation known as "creation science."<sup>26</sup>

This is false in several ways. First, intelligent design theory is not "anti-evolution"—it is quite compatible with common descent. Rather, intelligent design challenges only Darwin's particular theory of evolution; it challenges the unintelligent mechanism of random mutation and natural selection. Second, intelligent design is not a re-formulation of "creation science." This assertion seems to be an attempt to impute guilt by association. In fact, as I argued in my own expert report, intelligent design requires belief in none of the tenets of "creationism".

Related to this, Miller calls intelligent design theory a "theological explanation", and quotes president of the National Academy of Sciences Bruce Alberts calling design a "supernatural explanation"<sup>27</sup>. These are both incorrect characterizations. Design theory is no more a supernatural explanation than is the Big Bang theory, which some scientists also thought had theological implications. Both the Big Bang theory and intelligent design theory are based exclusively on physical, empirical, observable evidence, plus logical inferences, as I showed in my own expert report. The fact that some people think design may have extra-scientific implications no more makes the theory itself "theological" than it does for the Big Bang theory.

##### 4.2 Miller on evidence, falsifiability, and testability

Miller goes on to assert that design "presents no evidence." That's a surprising assertion, since in his following two sections ("The Biochemical Challenge to Evolution" and "The Informational Challenge to Evolution") he argues against the evidence that ID proponents have presented. Being unpersuaded by evidence that some people present doesn't allow one to say that they haven't presented any evidence.

Miller asserts here that "the 'design' explanation is not testable."<sup>28</sup> However, he glaringly contradicts himself. In various writings he himself has argued that scientific results show design to be wrong. For example, in his book *Finding Darwin's God* (which, as its name suggests, deals heavily with Miller's theological views), Miller discussed experiments on something called the lac operon of bacteria, and declared at the end that the results show

"Behe is wrong."<sup>29</sup> In fact, in his expert report itself Miller argues that results on something called the type III secretory system (TTSS) count against the intelligent design claims. (I have refuted both of Miller's claims.<sup>30</sup>) Now, one can't have it both ways. One can't say both that intelligent design is untestable, and that there is evidence against it. If it were indeed untestable, as Miller asserts in this section, then no physical evidence could be adduced against it at all. Miller's assertion that design is untestable is wrong, and it directly contradicts other statements he has made.

#### 4.3 The science classroom and "passing scientific scrutiny"

Miller claims that "Until 'design' passes scientific scrutiny, it has no place in science classrooms or textbooks."<sup>31</sup> The Dover policy, I understand, does not in fact seek to discuss design in the classroom, so this is irrelevant. Nonetheless, I disagree with Miller. Miller's statement confuses the high school science classroom with a meeting of professional scientists, and applies to the classroom rules that are totally inappropriate for the broad education of students. A high school science classroom might very appropriately consider issues more broadly than a professional science organization would, because most students are not going to be professional scientists. However, as adults all students will be citizens who have to participate in our democracy, and judge between competing claims of different factions, including the claims of scientific organizations on topics like global warming, the feasibility of different proposed weapons systems such as a "Star Wars" type missile defense, cloning, and even what is the appropriate level of funding for government-sponsored scientific research when balanced against other societal concerns. Thus, in my opinion it is entirely appropriate for a high school science classroom to consider a wide range of issues that impinge on the interaction of science with the larger culture. (As an example, in a Miller and Levine textbook they devoted sections to talking about social concerns on pollution and overpopulation — topics which explore the interface of science with larger human issues.<sup>32</sup>) Thus even if the majority of the scientific community disapproves of intelligent design, there nonetheless can be sound pedagogical reasons for discussing the topic in high school science classrooms.

For example, in a recent article in the London *Telegraph* entitled "Leading scientific journals 'are censoring debate on global warming'", some scientists charged that their research on global warming was turned down for publication by some science journals because it did not support the majority view.<sup>33</sup> The article is appended as an exhibit. It could be an excellent pedagogical exercise for students to discuss such minority views of scientists, and whether social factors operate in science (as they also do outside of science) to bolster a consensus view.

## 5 "The Biochemical Challenge to Evolution"

### 5.1 Miller reprises a disputed argument on the bacterial flagellum

In this section Miller reprises an argument against the irreducible complexity of the bacterial

flagellum that he published as a chapter in the book *Debating Design*.<sup>34</sup> In turn, I also contributed a chapter to the same book entitled "Irreducible Complexity: Obstacle to Darwinian Evolution"<sup>35</sup>, refuting Miller's argument. Briefly, I argued that Miller is making up his own definition of "irreducible complexity" and arguing against that, rather than against what I proposed in *Darwin's Black Box*.<sup>36</sup> In short, I say that he is arguing against a straw man. Miller claims that the parts of an irreducibly complex system must have no function apart from the system under consideration. However, I never claimed that. Quite the contrary. I had written that if a part is removed from an irreducibly complex system, then the function of the system is lost — not that the part itself couldn't be used for another purpose. Thus if one removes the hook, or flagellar tail, or motor, or drive shaft from the flagellum (see the drawing of the flagellum which I included as Exhibit 2 of my expert report), the system can no longer function as a propulsion device. The fact that there are ancillary functions of the system (such as the ability to act as a protein pump), as Miller points out, is irrelevant.

Miller claims there have been "detailed rebuttals" of irreducible complexity and design, and lists several publications. However, two of the papers cited by Miller (Coyne 1996 and Miller 1996) are merely book reviews, and another is by a rhetorician (Depew 1998) rather than a scientist. Only the publication by Thornhill and Ussery (2000) is a scientific article. That article is a conceptual study that does not deal with the biological realities that Darwinian evolution would face. An article published by David Snoke and myself shows that Darwinian processes could face severe hurdles in producing even relatively simple irreducibly complex systems.<sup>37</sup>

## 5.2 Miller concedes cells are filled with unexplained, complex structures

Miller makes a striking admission:

Living cells are filled, of course, with complex structures which have only recently become accessible to scientific observation and study, and whose detailed evolutionary origins are therefore not known. Therefore, in fashioning an argument against evolution one might pick nearly any cellular structure, the ribosome for example, and claim — correctly — that its origin has not been explained in detail by evolution.<sup>38</sup>

In other words, Miller agrees that Darwinian evolution has not yet explained the phenomenal complexity that science has discovered at the foundation of life. It is my opinion that this concession is pretty much the whole ball of wax, in terms of whether it is legitimate to discuss problems with Darwinian evolution in the classroom. If science has discovered great complexity in the cell, and if that has not yet been explained, then students should be apprised of the fact. Indeed, it would be misleading students to not emphasize this important fact.

## 5.3 Incredulity vs. credulity, gullibility vs. skepticism



Miller writes here disparagingly of "the argument from personal incredulity"<sup>39</sup>, belittling people who don't concede without evidence that Darwinian processes can explain the molecular complexity which he nonetheless admits is as yet unexplained. However, **skepticism is a healthy response in science** to large, unsupported claims. **Scientists are supposed to be skeptical**. The claim that the bacterial flagellum, the ribosome, or the many other phenomenally complex molecular machines science has discovered in the cell — that they could be produced by random mutation and natural selection, is a large unsupported claim for which the proper scientific response is a healthy skepticism. Should we teach students to be skeptical, or to be credulous?

#### 5.4 Miller exaggerates the significance of speculative Darwinian papers

Miller also lists a number of papers which he claims demonstrate how "evolution" could produce a number of complex systems. Once again, however, intelligent design does not dispute "evolution" — ID focuses exclusively on whether unintelligent mechanisms such as Darwin's natural selection can explain a biological system, or whether intelligence seems indicated. For none of the papers listed by Miller has it been shown in detail that random mutation and natural selection could have produced the system under consideration. For example, Miller cites a paper by Klein and Nikolaidis (2005)<sup>40</sup>, which considers the vertebrate immune system. However, the phrase "natural selection" does not occur in the paper, and the word "selection" appears only once. The word "mutation" appears only twice, but the envisioned mutations are not specified. Other words that do appear frequently include "probably", "imagine", "may have", "might have", and so on. In other words, the article is highly speculative, and to a skeptic of Darwinian theory it appears quite unconvincing and too vague to specifically criticize. At the end of their paper the authors suggest several experiments to be done at some point in the future; otherwise, they say, their suggested scenario would "remain hopelessly in the realm of mere speculations." In other words, the authors themselves agree their paper is merely speculative. It is interesting to note that the view that the authors are arguing against is the view of other scientists who think the following: "According to a currently popular view, the 'big bang' hypothesis, the [adaptive immune system] arose suddenly, within a relatively short time interval, in association with the postulated two rounds of genome-wide duplications." Thus most scientists in the field think that the immune system arose suddenly, which is difficult to square with a Darwinian process.

Certainly Darwinian biologists are free to speculate about the many mysteries of biology. **But their speculations should not be mistaken for experimentally verified answers. Students should learn to distinguish between speculations and confirmed answers.**

#### 6 "The Informational Challenge to Evolution"

##### 6.1 Miller overlooks problems that Dembski recognizes

Miller's rejoinder to William Dembski is primarily to question Dembski's probability model.

However, Miller himself misunderstands the difficulties involved, and so overlooks the problem. Miller's argument is that the probabilities of origination, localization, and assembly of proteins in a molecular machine such as the flagellum, which Dembski treats separately, actually are all part of the probability of finding the right sequences, since the information for localization and assembly reside in protein sequences. Writes Miller: "Therefore, if one gets the sequences of all the proteins right, localization and assembly will take care of themselves."<sup>41</sup>

To explain Miller's misunderstanding, let me use an analogy. Suppose five pieces that were to be assembled into a machine were manufactured in separate cities. Suppose that they then had to be sent through the mail to a particular place to be assembled. Suppose further that the address to which they needed to be sent was stamped on each piece, so that the mail delivery system knew where to send them. Now, here is the point. The address stamped on each piece of machinery is *extra* information — over and above the simple requirement for the piece to function — that has to be added for the system to be put together. (If that information were not present, the piece would not be shipped to the proper assembly point.) The fact that the address is stamped on the piece itself, rather than, say, being temporarily attached as a separate tag, does not in the least mitigate the fact that the information has to be there, and that the information is in addition to the information needed to shape the piece so it will work. In the same way, the fact that the information required to localize a protein to the right position in the cell so that it can be assembled into a molecular machine resides in the protein sequence itself does not at all decrease the amount of information that is required.

Thus, it is my scientific opinion that Dembski is approaching the problem in a reasonable way, and that Miller simply fails to see problems that are indeed there.

## 6.2 Miller faults ID theory for being tentative and falsifiable

In this section Miller also takes Dembski to task for happily conceding that future events may prove his model to be wrong. Miller quotes Dembski saying, "Now it can happen that we may not know enough to determine all the relevant chance hypotheses. Alternatively, we might think we know the relevant chance hypotheses, but later discover that we missed a crucial one."<sup>42</sup> As Dembski writes, if that happened the model "would be mistaken." **But that simply means that Dembski's model is tentative, testable, and falsifiable**, which is exactly what a scientific model is supposed to be. Is Miller complaining because Dembski can't guarantee the model is infallible? What scientific theory is infallible?

In fact, Miller's reasoning comes close to making Darwinian theory itself untestable and unfalsifiable. If the failure to find a plausible Darwinian evolutionary pathway does not count against the theory, then it is very difficult to see what would lead one to conclude Darwinian theory was wrong. Does Miller think we are obliged to wait an infinite amount of time to see if a plausible pathway turns up? That effectively would remove Darwinian theory from ever being discredited. No wonder Miller wrote earlier (page 3) that "not a single piece of



evidence" contradicts Darwinism. If one is obliged to rule out an infinite number of possible pathways before being skeptical of Darwinism or considering alternatives, then as a practical matter there can never be evidence against the theory.

In the subsection called "The Origin of Biological Information" Miller cites a number of papers and claims that they show "that information does indeed arise through distinctly Darwinian mechanisms." However, they show no such thing. Like the earlier papers cited by Miller, these too are either speculative, or deal in highly artificial computer models — not with real living systems. In a recent paper I co-authored with David Snoke, we showed that there are good reasons to think that Darwinian mechanisms cannot account for systems of substantial irreducible complexity.<sup>43</sup>

## 7 Miller's criticism of *Pandas*' Molecular Evidence

### 7.1 Miller ignores the controversy of the "molecular clock hypothesis"

#### 7.1.1 A brief explanation of the hypothesis

In his final section Miller severely criticizes *Pandas*' Chapter 6, which concerns similarities in amino acid sequences between similar proteins from different species. A few of Miller's comments include: "*Pandas*' entire Chapter 6 (on Biochemical similarities) is based on an incorrect representation of evolutionary theory" and "I cannot even imagine a greater misrepresentation of fundamental data to support an incorrect conclusion." Instead Miller claims "the protein sequences of every animal in that group should be equidistant from any single invertebrate. And that is exactly what the experimental data show."<sup>44</sup>

Miller is wrong. He either is unaware of the controversy around the similarity of protein sequences or else he is ignoring critical parts of it. Below is a brief explanation.

In the early 1960s information began to be available concerning the exact amino acid sequence of homologous proteins ("homologous" means features presumably inherited from a common ancestor) in different organisms, for example human cytochrome c (a protein involved in cellular energy production), dog cytochrome c, kangaroo cytochrome c, and so on. The results were intriguing: the sequences of human and dog cytochrome c's were similar but not identical. Kangaroo cytochrome c was less similar to human than was that of dog. The further the source organism was biologically from humans, the less similar was its cytochrome c. To explain this phenomenon in the 1960's Emile Zuckerkandl and Linus Pauling proposed something called the "molecular clock hypothesis."<sup>45</sup>

Briefly, the molecular clock hypothesis proposes that after a species splits into two species, in the separate lines of the descendant species homologous proteins independently accumulate changes (mutations) at a roughly constant rate over time. If that assumption is indeed the case, then when two separate branches split off from a common ancestor, then each branch should on average have accumulated roughly the same number of mutations up to the present. That means that all branches should be about the same distance from a common ancestor, which is what we usually see. So, for example, mammal and bird proteins

should be equally distant from plant proteins, since the line leading to mammals and birds diverged at the same time from that leading to plants.

At first blush that sounds quite reasonable, but on further reflection there are difficulties. Indeed, the molecular clock hypothesis was controversial from its first proposal, and continues to be controversial today.<sup>46</sup> Indeed, the last sentence of a recent review of the topic in *The American Biology Teacher* is, "Therefore the validity of a molecular clock except in closely related species still remains controversial."<sup>47</sup> (I append the article as an exhibit.) There are several reasons for the controversy. The first reason is that the hypothesis seems to require that mutations accumulate in the protein sequence in a roughly neutral fashion, that is, without affecting the function of the protein to a large degree. Many scientists, however, expected most amino acid mutations to be either favorable or unfavorable for an organism — not neutral. Second, the molecular clock seems to "tick" at very different rates in different proteins, and even in different regions within the same protein. That requires further modifications of the hypothesis to take into account whether a region of a protein may or may not accumulate mutations with greater tolerance than another region. Third, the constant rate seems to suggest that the similar proteins would unexpectedly experience similar selective pressures in vastly different biological lineages (for example, the cytochrome c's of birds and fish).

Finally, even in the absence of those other factors, why the clock should tick at a constant rate is hard to understand. The puzzle is that most scientists expect the number of mutations in a lineage to vary with an organism's generation time (the average time between generations), because when an organism replicates mutations can occur as its DNA is copied. This consideration suggests that species with short generation times (fruit flies reproduce on the order of every few weeks) should accumulate more mutations than ones with longer generation times (elephants reproduce on the order of decades). Yet that seems not to happen.

Some hypotheses have been offered to try to account for the lack of a generation-time effect, but it remains controversial.

#### 7.1.2 *Pandas* alerts students to a problem that Miller ignores

*Pandas* is indeed incorrect in saying (to quote Miller) that "evolution predicts" a linear arrangement of protein sequences for similar proteins. In fact, although such an arrangement sounds reasonable, and if it occurred Darwinists would have no trouble whatsoever in accommodating it to their theory, in reality Darwinian evolution makes virtually no necessary prediction whatsoever on this topic, which is why Darwinian biologists such as Zuckerkandl, Ayala, and Ohta could be on opposite sides of the argument over the molecular clock.

It is my scientific opinion, however, that *Pandas* performs a very useful pedagogical service in calling attention to the phenomenon of protein sequence similarity and the critical role that assumptions play in models that try to explain the phenomenon. Amino acid sequence

similarity is a fact in need of explanation, the explanation is not settled, and a whole host of assumptions about the way life works go into forming possible explanations. To the extent that *Pandas* alerts students to the way biological explanations frequently rely on unverifiable assumptions (no matter how reasonable workers think the assumptions are) about past molecular events and on ad hoc theorizing to attempt to fit a theory to an explanation, it will be educating them in an important area that is neglected in most science textbooks.

## 7.2 Miller's tendentiousness

Miller declares:

The real story is that the fossil record clearly shows that the entire vertebrate group (including frogs and people) split off from the invertebrates (including worms) many hundreds of millions of years ago. Therefore, the protein sequences of every animal in that group should be *equidistant* from any single invertebrate. And that is exactly what the experimental data show...<sup>48</sup>

Although he couches his statement in forceful prose, Miller is quite incorrect in his claim that Darwinian theory requires that the sequences "should be" anything in particular. Rather, Miller is looking at the protein sequence data and then seeking to justify them post hoc using a simple molecular clock model. In doing so he is ignoring difficulties that have been known to workers in the field ever since the 1960s. He is ignoring the work that is currently going on by Darwinian evolutionary biologists to try to rationalize the data within a Darwinian framework.<sup>49</sup>

Assuming that Miller is simply unaware of the molecular clock controversy and adopts the Zuckerkandl-Pauling view without consideration of thoughtful objections to it, then Miller's writing in this section is itself an excellent example of the way adherence to a theory (here Darwinism mixed with a simplistic, unthinking molecular clock model) can color the views of a scientist to the point of ignoring difficulties. His high dudgeon against *Pandas* for treating a live scientific controversy that he himself shows no signs of appreciating is an example of the intolerance some scientists can sometimes show when they think their basic assumptions are being questioned.

Signed: \_\_\_\_\_

Date: \_\_\_\_\_

05/15/2005 12:46 6107584004

LU BIO SCI.

PAGE 03/03

Assuming that Miller is simply unaware of the molecular clock controversy and adopts the Zuckerkandl-Pauling view without consideration of thoughtful objections to it, then Miller's writing in this section is itself an excellent example of the way adherence to a theory (here Darwinism mixed with a simplistic, unthinking molecular clock model) can color the views of a scientist to the point of ignoring difficulties. His high dudgeon against Pendas for treating a live scientific controversy that he himself shows no signs of appreciating is an example of the intolerance some scientists can sometimes show when they think their basic assumptions are being questioned.

Signed: Michael J. Behe Date: May 15, 2005

#### ENDNOTES

1. Kauffman, S.A. 1993. *The origins of order :self-organization and selection in evolution*. Oxford University Press: New York.
2. Miller, K. R. Expert Statement, p. 3.
3. Miller, K. R. Expert Statement, p. 7.
4. Miller, K. R. Expert Statement, p. 4.
5. For example, see Dawkins, R. 1986. *The blind watchmaker*. Norton: New York., pp. 200-201.
6. Miller, K. R. Expert Statement, p. 4.
7. Behe, M. J. Expert report, p. 19.
8. Miller, K. R. Expert Statement, p. 3.
9. Behe, M.J. Expert report, p. 25.
10. Miller, K. R. Expert Statement, p. 5.
11. Miller, K. R. Expert Statement, p. 5.
12. Miller, K. R. Expert Statement, p. 7.
13. Miller, K. R. Expert Statement, p. 8.
14. Miller, K. R. Expert Statement, p. 8-9.
15. Ruse, M. 1982. *Darwinism defended: a guide to the evolution controversies*. Addison-Wesley, Advanced Book Program/World Science Division: Reading, Mass., p. 58. Emphasis in original.
16. Alvin Plantinga, "On Christian Scholarship", in *The Challenge and Promise of a Catholic University*, ed. Theodore Hesburgh (Notre Dame and London: University of Notre Dame Press, 1994), <http://id-www.ucsb.edu/fscf/library/plantinga/OCS.html#1>
17. Miller, K.R. and Levine, J. 1995. *Biology*, 3rd ed. Prentice Hall: Englewood Cliffs, NJ, p. 313.
18. Miller, K.R. 1999. *Finding Darwin's God: a scientist's search for common ground between God and evolution*. Cliff Street Books: New York, p. 253.

19. Dawkins, R. 1986. *The blind watchmaker*. Norton: New York, p. 6.
20. Dennett DC. 1995. *Darwin's dangerous idea: evolution and the meanings of life*. New York: Simon & Schuster.
21. Dennett DC. 1995. *Darwin's dangerous idea: evolution and the meanings of life*. New York: Simon & Schuster, p. 63.
22. Sommers, T. and Rosenberg, A. 2003. Darwin's nihilistic idea: evolution and the meaninglessness of life. *Biology and Philosophy* 18:653-658.
23. Blurb at Amazon.com, [http://www.amazon.com/exec/obidos/tg/detail/-/0791436942/qid=1115660211/sr=8-2/ref=sr\\_8\\_xs\\_ap\\_i2\\_xgl14/103-3873323-7193413?v=glance&s=books&n=507846](http://www.amazon.com/exec/obidos/tg/detail/-/0791436942/qid=1115660211/sr=8-2/ref=sr_8_xs_ap_i2_xgl14/103-3873323-7193413?v=glance&s=books&n=507846)
24. Blurb at Amazon.com, [http://www.amazon.com/exec/obidos/tg/detail/-/B0008E5MMO/qid=1115660413/sr=1-1/ref=sr\\_1\\_1/103-3873323-7193413?v=glance&s=books](http://www.amazon.com/exec/obidos/tg/detail/-/B0008E5MMO/qid=1115660413/sr=1-1/ref=sr_1_1/103-3873323-7193413?v=glance&s=books)
25. Blurb at Amazon.com, [http://www.amazon.com/exec/obidos/ASIN/0415970148/qid=1115660544/sr=2-1/ref=pd\\_bbs\\_b\\_2\\_1/103-3873323-7193413](http://www.amazon.com/exec/obidos/ASIN/0415970148/qid=1115660544/sr=2-1/ref=pd_bbs_b_2_1/103-3873323-7193413)
26. Miller, K. R. Expert Statement, p. 11.
27. Miller, K. R. Expert Statement, p. 11.
28. Miller, K. R. Expert Statement, p. 11.
29. Miller, K.R. 1999. *Finding Darwin's God: a scientist's search for common ground between God and evolution*. Cliff Street Books: New York, p. 147.
30. Behe, M.J. 2001. Reply to my critics: A response to reviews of *Darwin's Black Box: the biochemical challenge to evolution*. *Biology and Philosophy* 16:685-709; Behe, M.J. 2004. Irreducible Complexity: Obstacle to Darwinian Evolution. In *Debating Design: from Darwin to DNA*. (eds. W.A. Dembski and M. Ruse), pp 352-370. Cambridge University Press: Cambridge.
31. Miller, K. R. Expert Statement, p. 11.
32. Miller, K.R. and Levine, J. 1995. *Biology*, 3rd ed. Prentice Hall: Englewood Cliffs, NJ, Chapter 49.
33. Matthews, R. Leading scientific journals 'are censoring debate on global warming'. news.telegraph. 1-5-2005. [www.telegraph.co.uk/news/main.jhtml?xml=/news/2005/05/01/wglob01.xml](http://www.telegraph.co.uk/news/main.jhtml?xml=/news/2005/05/01/wglob01.xml)



34. Dembski, W.A. and Ruse, M. 2004. *Debating design: from Darwin to DNA*. Cambridge University Press: Cambridge, U.K.
35. Behe, M.J. 2004. Irreducible Complexity: Obstacle to Darwinian Evolution. In *Debating Design: from Darwin to DNA*. (eds. W.A. Dembski and M. Ruse), pp 352-370. Cambridge University Press: Cambridge.
36. Behe, M.J. 1996. *Darwin's black box :the biochemical challenge to evolution*. The Free Press: New York.
37. Behe, M.J. and Snoke, D.W. 2004. Simulating evolution by gene duplication of protein features that require multiple amino acid residues. *Protein Sci.* **13**:2651-2664.
38. Miller, K. R. Expert Statement, p. 13.
39. Miller, K. R. Expert Statement, p. 12.
40. Klein J, Nikolaidis N. 2005. The descent of the antibody-based immune system by gradual evolution. *Proc Natl Acad Sci U S A* **102**:169-174.
41. Miller, K. R. Expert Statement, p. 16.
42. Miller, K. R. Expert Statement, p. 17.
43. Behe, M.J. and Snoke, D.W. 2004. Simulating evolution by gene duplication of protein features that require multiple amino acid residues. *Protein Sci.* **13**:2651-2664.
44. Miller, K. R. Expert Statement, p. 22-23.
45. Zuckerkandl E, Pauling L. 1965. In: Bryson V, Vogel HJ, eds. *Evolving Genes and Proteins*. New York: Academic Press. pp 97-166.
46. For example, see Ayala, F.J. 2000. Neutralism and selectionism: the molecular clock. *Gene* **261**:27-33; Gillooly, J.F., Allen, A.P., West, G.B., and Brown, J.H. 2005. The rate of DNA evolution: effects of body size and temperature on the molecular clock. *Proc. Natl. Acad. Sci. U. S. A* **102**:140-145; Ayala, F.J. 1997. Vagaries of the molecular clock. *Proc. Natl. Acad. Sci. U. S. A* **94**:7776-7783; Ohta, T. 1993. An examination of the generation-time effect on molecular evolution. *Proc. Natl. Acad. Sci. U. S. A* **90**:10676-10680.
47. Hermann, G. 2003. Current status of the molecular clock hypothesis. *The American Biology Teacher* **65**: 661-663.
48. Miller, K. R. Expert Statement, p. 23.

49. Gillooly, J.F., Allen, A.P., West, G.B., and Brown, J.H. 2005. The rate of DNA evolution: effects of body size and temperature on the molecular clock. *Proc. Natl. Acad. Sci. U. S. A* **102**:140-145.